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EXAMINER	
SELLERS, DANIEL R	
ART UNIT	**PAPER NUMBER**
2644	

DATE MAILED: 09/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/766,599	TAYLOR ET AL.	
	Examiner	Art Unit	
	Daniel R. Sellers	2644	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 20 June 2005.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-24 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-24 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 27 January 2004 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1, 2, and 4-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over the IEEE Nuclear Science Symposium and Medical Imaging Conference paper titled "Application of DSP Techniques to Nuclear Magnetic Resonance Spectroscopy" by Worley et al. and Keller et al., U.S. Pat. No. 5,041,789 (hereinafter Worley and Keller respectively).

3. Regarding claim 1, Worley teaches

An apparatus for performing spectral analysis, the apparatus comprising:
a. a data acquisition system configured to measure a signal emitted from a sample in response to excitation energy applied thereto (col. 1, first paragraph), *and to average the measured signal over a plurality of measurements to generate an averaged signal* (col. 3, first paragraph),

b. a data processing system including:
a noise-reduction pre-processor configured to create a vector space from said averaged signal, and to generate the singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space, said vector space containing a noisefree signal subspace and a noise subspace, said singular values including noisefree singular values associated with said noisefree signal subspace, and noise singular values associated with said noise subspace (col. 3, second paragraph); *and*

c. a control system configured to identify a gap between a noisefree singular value and an adjacent noise singular value, so as to request the data acquisition system to perform additional measurements if no such separation can be identified, and to prevent further measurements from being made by the data acquisition system if the appearance and stability of said gap can be established.

Worley teaches a data acquisition system that averages the measurements over a plurality of samples and teaches a data processing system that performs eigendecomposition on the measurements. Eigendecomposition (or Singular Value Decomposition) involves transforming the input data into eigenvalues and their corresponding eigenvectors. A matrix of M by N dimensions can be viewed as a set of

M vectors of N length or N vectors of M length (i.e. a 3x3 matrix has 3 dimensions or is a vector space with 3 dimensions). Worley teaches that the eigendecomposition creates an eigenspace with a noise and a noisefree subspace. It is well known that singular values are eigenvalues. Worley does not teach the control system. Keller teaches a control system in an NMR system that prevents further measurements from being made when a gap is identified or a minimum signal-to-noise ratio (SNR) is reached (Col. 9, lines 11-37). It would have been obvious for one of ordinary skill in the art to combine the teachings of Worley and Keller for the purpose of creating a more user-friendly device. It is obvious that a minimum SNR criteria includes finding a stable gap between the noise and the noisefree singular values, wherein the SNR defines the magnitude difference between those singular values.

4. Regarding claim 2, with respect to claim 1, the further limitation,

... said spectral analysis comprises an NMR spectral analysis, said excitation energy comprises RF excitation pulses, and said measured signal comprises an NMR transient.

See claim 1, Worley teaches a system that performs singular value decomposition in NMR spectral analysis.

5. Regarding claim 4, with respect to claim 1, the further limitation, see Worley,

... said noise-reduction preprocessor comprises:

a. a matrix generator configured to form a vector space from the averaged signal (col. 3, first paragraph) *and constructing a correlation matrix within the vector space, the vector space containing a noisefree signal subspace and a noise subspace;* (col. 3, second paragraph).

b. a matrix diagonalizer configured to diagonalize the correlation matrix to obtain its singular values and the corresponding eigenvectors, the singular values including noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace, and

c. a signal projector configured to project the averaged signal onto the noisefree subspace to generate a noise-reduced signal. (Col. 3, end of second paragraph).

With regard to the preceding limitation that the correlation matrix is diagonalized, it is a well-known step in the art of singular value decomposition or eigendecomposition, and as such is inherent. Worley teaches, at the end of the second paragraph in the third column, that "eigenvectors are then used to construct a spectrum estimate.", wherein it is inherent that the signal is reconstructed by projecting the signal onto the signal subspace and ignoring the space comprised of the noise vectors.

6. Regarding claim 5, with respect to claim 4, the further limitation, see the preceding argument with respect to claim 4. Worley and Keller teach the features of the preceding claim and Worley teaches that a spectrum is created using the eigenvectors. It is inherent that a frequency domain transform is used to create the spectrum.

7. Regarding claim 6, with respect to claim 1, the further limitation, see Worley

... said data acquisition system is configured to sample each measured signal with a sampling period .:, and to average the corresponding sample points over said plurality of measurements (col. 3, first paragraph)*, so as to store said averaged signal as a discretized set of N data points c_n (n = 0, . . . , N-1).*

Worley does not teach a system with a sampling period or a step of discretizing the input. Since Worley uses DSP techniques, sampling with an appropriate frequency (at least twice the highest signal frequency) and digitizing the samples would have been obvious in order to perform DSP.

8. Regarding claim 7, with respect to claim 6, the further limitation

... said data processing system is configured to store each data point c_n as a noisefree component x_n (n = 0, . . . , N-1) and a noise component M_n (n = 0, . . . , N-1), and to store each noisefree component x_n as a finite sum of damped complex harmonics weighted by respective coefficients.

Worley teaches a system that separates the signal into two subspaces by means of singular value decomposition (col. 3, second paragraph). It would have been obvious

that the signal when separated into its components would have been stored as the noisefree component and the noise component. Worley does not teach a system that stores damped complex harmonics, however Worley teaches that prior art used the discrete Fourier transform to create spectral information from NMR transients. It would have been obvious to one of ordinary skill in the art to use these teachings to create a device that stores the noisefree components as a finite sum of damped complex harmonics weighted by coefficients, in order to save computational time by converting to the frequency domain only once.

9. Regarding claim 8, with respect to claim 7, the further limitation,

... said sum is over a number K of said damped complex harmonics, so that each noisefree component x_n can be stored as:

$x_n = ; d_k \exp(-iw_k .\because n)$

where d_k represents the weighting coefficient of the k-th damped complex harmonics, and w_k represents the complex frequency of the k-th damped complex harmonics.

See the rejection of claim 7, prior art teaches the use of Fourier techniques in spectral analysis. It would have been obvious to require the storage of coefficients corresponding to complex frequencies, as this is a well known method in the art.

10. Claims 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Worley and Keller as applied to claims 1, 2, and 4-8 above, and further in view of Trickett, U.S. Patent Application Publication 2004/0054479.

11. Regarding claims 9 and 10, with respect to claims 1 and 9 respectively, the further limitation of claim 9, see Trickett,

... said data acquisition system further comprises a windowing subsystem configured to apply a windowing filter to a Fourier transform of said averaged signal, so as to generate one or more decimated signals having a limited bandwidth. (fig. 5, unit 530)

and the further limitation of claim 10, see Trickett

... said data processing system is configured to store the inverse Fourier transform (fig. 5, unit 570) *of each decimated signal as a set of N_d decimated data points c_n^d ($n = 0,\ldots, N_d-1$), and wherein said set of decimated data points have a signal length N_d that is substantially less than N and a sampling period T_d that is substantially greater than ...*

The application of Trickett teaches a method of noise reduction using matrix rank reduction. Trickett does not teach a system that uses averaged signals, however Worley et al. specifically teaches that averaged NMR transients are used as an input to the system. It is inherent that the decimated data points have a smaller signal length and a sampling period greater than the input sampling frequency. It would have been obvious to one of ordinary skill in the art to combine these teachings, in order to reduce the amount of time involved in processing the data (Trickett, paragraph 17, lines 3-6).

12. Regarding claim 11, with respect to claim 10, the further limitation,

... said vector space created by said noise-reduction pre-processor comprises an M-dimensional vector space defined by a number $N_d - M + 1$ of linearly independent M-dimensional vectors, and wherein said data processing system is configured to store said M-dimensional vectors in a form given by:

$c_n^d = (c_n^d, c_{n+1}^d, \ldots, c_{n+M-1}^d)$,

where c_n^d represent said decimated data points.

Worley et al. teaches a system that creates an M-dimensional vector space from NMR transients. It is inherent that the system stores the M-dimensional vectors. Trickett teaches the method of decimating the data. It would have been obvious to one of ordinary skill in the art to combine these teachings as stated previously, in order to store data more efficiently.

13. Regarding claim 12, with respect to claim 11, the further limitation

... said correlation matrix constructed by said matrix generator is Hermitian and covariant, and has a dimension MxM, and wherein said correlation matrix is formed from said M-dimensional vectors and in accordance with a formula given by:

$R_{ij} = 1 / (N_d - M + 1) ; c_{n+i-1} c^*_{n+j-1}$

See Worley column 3, second paragraph. Worley teaches a system that uses an autocorrelation function. It is well known in the art that in certain cases an autocorrelation matrix is both Hermitian and covariant, specifically in the case of real valued stationary random sequences with zero mean.

14. Regarding claim 13, with respect to claim 11, see the preceding argument with respect to claim 4

... said projection of said averaged signal by said signal projector is based on a projection formula given by:

$c_n^{nr} = ;_{k=1...K} (u^*_k, c_n) u_k$

where u_k represent said eigenvectors corresponding to said singular values.

Worley teaches a system analyzer that uses singular value decomposition techniques. The system as taught by Worley, inherently includes a method of projecting a signal onto eigenvectors.

15. Claims 3, and 14-24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Worley and Keller as applied to claim 1 above and in further view of Broomhead et al., and Okazaki (hereinafter Broomhead and Okazaki respectively).

16. Regarding claim 3, with respect to claim 1, the further limitation, see Broomhead

... said control system comprises:

a. a graphics system adapted to generate a plot of said singular values, (fig. 4a and 5a)

b. a pattern recognition system adapted to identify a gap in said plot between said noisefree singular value and said adjacent noise singular value, and to verify the stability of said gap; and

c. a command signal generator, responsive to said pattern recognition system, configured to generate an output signal requesting for more measurements from said data acquisition system, in the absence of an definable gap, and to generate an output signal requesting that further measurements be discontinued, if the appearance and the stability of said gap has been established by said pattern recognition system.

Broomhead et al. teaches a processing system that performs singular value decomposition of time series signals from non-linear systems. The system does not perform pattern recognition, however the teachings point out the specific characteristics of the singular value plot (col. 12, lines 36-57). The system also does not request or discontinue further measurements. Keller teaches a system that request or discontinues further measurements. Okazaki teaches a pattern recognition system for identifying and retrieving two-dimensional information (col. 1, lines 18-31). Okazaki teaches that the system can be configured to recognize retrieval conditions (col. 2, lines 7-18). It would have been obvious to one of ordinary skill in the art to combine these teachings of Worley, Keller, Broomhead, and Okazaki for the purpose of creating a more user-friendly system. These systems when combined would shorten the length of time needed to acquire signals of interest.

17. Regarding independent claims 14-19, 21, and 24, see the rejections of claims 1-5. The combination of Worley, Keller, Broomhead, and Okazaki teaches these features.

18. Regarding claim 20, with respect to claim 19, the further limitation,

... said spectrum comprises an NMR spectrum, and said data measurements comprise NMR transient acquisitions.

Worley teaches a system that comprises an NMR spectrum and data measurements that comprise of NMR transient acquisitions (col. 1, first paragraph).

19. Regarding claim 22, the further limitation of claim 21,

... steps b, c, and d are implemented by an operator of a control system.

Broomhead teaches a processing system that performs singular value decomposition of time series signals from non-linear systems. They plot the singular values and point out specific characteristics present in the singular plot (fig. 4a, item 80). It is inherent that those specifics where chosen by the authors and furthermore it is inherent that an operator can choose those characteristics in the same manner.

20. Regarding claim 23, the further limitation of claim 21,

... steps b, c, and d are implemented by a processor upon execution by said processor of computer-usable instructions stored on a computer-usable medium.

Okazaki teaches a pattern recognition system to select user-defined characteristics of a 2-D plot, and Keller teaches a control system that responds to requests for additional measurements.

Response to Arguments

21. Applicant's arguments with respect to claims 1-24 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

22. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hutson, U.S. Patent 5,490,516A, and IEEE Transactions on Signal Processing "An Eigenanalysis Interference Canceler" by Haimovich et al. (provided in the last action).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel R. Sellers whose telephone number is 571-272-7528. The examiner can normally be reached on Monday to Friday, 9am to 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vivian Chin can be reached on 571-272-7848. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DRS

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